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THE DISPLAY OF TACTILE INFORMATION

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There are a number of examples of natural tactile displays that can give us some insights about the solid geometry of touch, and recent experimental work on the subject has extended our thinking considerably. The concern of this conference is, however, more with synthetic or artificial displays for the production of a virtual environment. The majority of the talk will dwell on the features of synthetic displays that have enjoyed some success in one of two enterprises: The study of the spatio-temporal dimensions of stimuli that afford accurate and rapid processing of environmental information, or the use of displays in the design of sensory aids for disabled persons.

Examples of synthetic displays are given, with some discussion of their application, success, and reasons for their failure, i.e., their current disuse. In the past, displays have been mainly of the type called diffuse, i.e., spread over a large area of the body. In more recent years, the improvements in electronic technology have made possible the production of more and more dense arrays of tactile stimulators, some of which, like the Optacon of Telesensory Systems, Inc., were developed for applied purposes, and now are used in basic research as well.

This conference is best served by my talk if I list some of the things that have been learned about the spatio-temporal properties of tactile displays that could be useful in the design of displays for teleoperator systems. One of these has to do with the site of the display, which is commonly of concern to sensory aids developers for reasons of comfort and appearance. In addition to such concerns, however, it has become clear that issues of efficiency of energy usage, related to the thresholds for feeling, and the needed dynamic range of such devices, are also important to the designer, and these parameters vary greatly with the site of stimulation. Of equal importance is spatial acuity, i.e., the discrimination of high spatial frequencies on the skin, which varies systematically with the location of the stimulus array.

There is a considerable literature dealing with such space-time phenomena as masking, real and apparent movement on the skin, temporal integration of both energy and coded information, saltation, and lateralization. These will be discussed in some detail as useful boundary conditions for device design.

Another class of phenomena exist that may appear at first to be too esoteric for applied consideration, but which, because they have only a short history of systematic research, deserve consideration for their potential in enriching the perceptual field of the tactile display. One of these is the interaction of touch with other modalities, and a good example is found in studies of the temperature sense. Another is the phenomenon of distal attribution, which involves the transference of the display properties from the veridical site of stimulation to the object being simulated by the display.

A final word will be said about the importance of the learning process in acquiring a little-used perceptual-motor skill, which teleoperator systems must demand of the user when an unusual source such as touch is incorporated into the information stream.